

PATENT COOPERATION TREATY
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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 599121C	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).	
International Application No. PCT/AU2003/000690	International Filing Date (day/month/year) 3 June 2003	Priority Date (day/month/year) 12 June 2002
International Patent Classification (IPC) or national classification and IPC Int. Cl. ⁷ H01Q 11/08, 1/36, 21/06		
Applicant THISS TECHNOLOGIES PTE LTD et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

 These annexes consist of a total of 9 sheet(s).

3. This report contains indications relating to the following items:

I	<input checked="" type="checkbox"/>	Basis of the report
II	<input type="checkbox"/>	Priority
III	<input type="checkbox"/>	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	<input type="checkbox"/>	Lack of unity of invention
V	<input checked="" type="checkbox"/>	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	<input type="checkbox"/>	Certain documents cited
VII	<input type="checkbox"/>	Certain defects in the international application
VIII	<input type="checkbox"/>	Certain observations on the international application

Date of submission of the demand 24 December 2003	Date of completion of the report 28 July 2004
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer Mani Ramachandran Telephone No. (02) 6283 2233

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/AU2003/000690

I. Basis of the report**1. With regard to the elements of the international application:***

- ☐ the international application as originally filed.
- ☒ the description, pages 1, 5-13, as originally filed,
pages , filed with the demand,
pages 2-4, received on 12 July 2004 with the letter of 12 July 2004
- ☒ the claims, pages , as originally filed,
pages , as amended (together with any statement) under Article 19,
pages , filed with the demand,
pages 14-19, received on 12 July 2004 with the letter of 12 July 2004
- ☒ the drawings, pages 1-14, as originally filed,
pages , filed with the demand,
pages , received on with the letter of
- ☐ the sequence listing part of the description:
pages , as originally filed
pages , filed with the demand
pages , received on with the letter of

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/fig.

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/AU2003/000690

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Claims 1-15	YES
	Claims	NO
Inventive step (IS)	Claims 1-15	YES
	Claims	NO
Industrial applicability (IA)	Claims 1-15	YES
	Claims	NO

2. Citations and explanations (Rule 70.7)**NOVELTY & INVENTIVE STEP Claims 1-15:**

The inventive concept is an antenna element comprising a ground plane, a cylindrical helix with a uniform pitch disposed above the ground plane and connectable to a communications apparatus at a first helix end near the ground plane, and a second helix end opposite the first helix end where the antenna termination has a lateral spiral substantially centred on the axis of the cylindrical helix.

None of the prior art documents, or an obvious combination of such documents, disclose a cylindrical uniform pitch helix antenna terminating in a lateral spiral at the end away from the ground plane.

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Summary

An antenna concept disclosed herein provides a simple medium gain antenna, based on a low profile helix terminated with a spiral. The antenna offers significantly higher antenna gain than patch antenna arrangements.

5 According to a first aspect of the invention, there is provided an antenna element comprising:

a ground plane:

a cylindrical helix having a uniform pitch, the cylindrical helix being disposed above the ground plane, the cylindrical helix being connectable to a communications apparatus at a first helix end, said first helix end being located near the ground plane; and

10 a lateral spiral substantially centred on the axis of the cylindrical helix, the spiral having a first end thereof connected to a second helix end, said second helix end being the opposite end of the cylindrical helix to the first helix end, said lateral spiral thereby terminating the antenna element.

15 According to another aspect of the invention, there is provided an antenna comprising:

a phased array feed network having an equipment feed-line for connection to communication apparatus and a plurality of element feed-lines for connection to a like plurality of cylindrical helix antenna elements, said phased array feed network being adapted to collectively connect said plurality of cylindrical helix antenna elements to the communication apparatus; and

20 said plurality of cylindrical helix antenna elements arranged in a domino pattern, each said cylindrical helix antenna element comprising a ground plane and a cylindrical helix having a uniform pitch disposed above the ground plane, each said cylindrical helix antenna element being individually connectable at a respective first cylindrical helix end located near the ground plane to a respective element feed-line of the phased array feed

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network to thereby connect said cylindrical helix antenna element to the communications apparatus, wherein each said cylindrical helix antenna element further comprises a lateral spiral substantially centred on the axis of the cylindrical helix the lateral spiral having a first end thereof connected to a second helix end being the opposite end of the cylindrical helix to the first helix end, said spiral thereby terminating the antenna. ⁵

According to another aspect of the invention, there is provided an antenna comprising:

a ground plane:

a plurality of cylindrical helices disposed above the ground plane, each said cylindrical helix being connectable, via a respective feed line of an associated phased array feed network to a communications apparatus, at a respective first helix end located near the ground plane; and

a like plurality of lateral spirals, each substantially centred on the axis of the corresponding one of the plurality of cylindrical helices, said each lateral spiral having a first end thereof connected to a second helix end of the corresponding one of the plurality of helices, said second helix end being the opposite end of the cylindrical helix to the first helix end, said lateral spiral thereby terminating the corresponding helix. ¹⁵

According to another aspect of the invention, there is provided an antenna comprising:

a ground plane: ²⁰

a plurality of cylindrical helices disposed above the ground plane, each said cylindrical helix being connectable, via a respective feed line of an associated switched element feed network to a communications apparatus, at a respective first helix end located near the ground plane; and

a like plurality of lateral spirals, each substantially centred on the axis of the corresponding one of the plurality of cylindrical helices, said each lateral spiral having a ²⁵

first end thereof connected to a second helix end of the corresponding one of the plurality of cylindrical helices, said lateral spiral thereby terminating the corresponding helix.

According to another aspect of the invention, there is provided a method of impedance matching a cylindrical helix antenna element wherein the cylindrical helix antenna element comprises a ground plane, a cylindrical helix having a uniform pitch disposed above the ground plane, the cylindrical helix being connectable to a communications apparatus at a first helix end located near the ground plane, and a lateral spiral substantially centred on the axis of the cylindrical helix the lateral spiral having a first end thereof connected to a second helix end, said second helix end being the opposite end of the cylindrical helix to the first helix end, said lateral spiral thereby terminating the cylindrical helix antenna, said method comprising the steps of:

adjusting a distance, from the ground plane, of the first helix end located near the ground plane to thereby adjust the impedance of a tapered transmission line formed between the ground plane and a first quarter turn of the cylindrical helix.

Other aspects of the invention are also disclosed.

Brief Description of the Drawings

One or more embodiments of the present invention will now be described with reference to the drawings, in which:

Fig. 1 shows the disclosed helix antenna;

Fig. 2 shows side and plan views of the antenna;

Fig. 3 shows a typical azimuth radiation pattern for the antenna;

Fig. 4A shows a switched antenna arrangement using the antenna;

Fig. 4B shows switch azimuth antenna gain patterns for the arrangement shown in Fig. 4A;

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The claims defining the invention are as follows:

1. An antenna element comprising:
a ground plane:
5 a cylindrical helix having a uniform pitch, the cylindrical helix being disposed above the ground plane, the cylindrical helix being connectable to a communications apparatus at a first helix end, said first helix end being located near the ground plane; and
a lateral spiral substantially centred on the axis of the cylindrical helix, the spiral having a first end thereof connected to a second helix end, said second helix end being the
10 opposite end of the cylindrical helix to the first helix end, said lateral spiral thereby terminating the antenna element.
2. An antenna element according to claim 1, wherein the axis of the cylindrical helix is substantially perpendicular to the ground plane.
- 15 3. An antenna element according to claim 1, wherein the lateral spiral lies in a flat plane that is substantially perpendicular to the axis of the helix.
4. An antenna element according to claim 1, further including a tapered
20 transmission line connected between the communications apparatus and the first end of the cylindrical helix located near the ground plane.
5. An antenna element according to claim 1, wherein:
the cylindrical helix has (a) between 1.5 and 3.5 turns, (b) a pitch angle of
25 between 3 and 7 degrees, and (c) a circumference of between 0.9 and 1.15 wavelengths;
and

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the lateral spiral has between 1 and 4 turns.

6. An antenna element according to claim 1, wherein:

the cylindrical helix has (a) between 3.5 and 40 turns, (b) a pitch angle of
5 between 10 and 14 degrees, and (c) a circumference of between 0.9 and 1.15
wavelengths; and

the lateral spiral has between 1 and 4 turns.

7. An antenna comprising:

10 a switched element feed network having an equipment feed-line for connection
to communication apparatus and a plurality of element feed-lines for connection to a like
plurality of cylindrical helix antenna elements according to claim 1, said switched
element feed network being adapted to connect a selected one of the cylindrical helix
antenna elements to the communication apparatus; and

15 said plurality of cylindrical helix antenna elements, said cylindrical helix antenna
elements being disposed above said ground plane, each said cylindrical helix antenna
element being individually connectable at a respective said first helix end located near the
ground plane to a respective element feed-line of the switched element feed network to
thereby connect to the communications apparatus.

20

8. An antenna comprising:

a phased array feed network having an equipment feed-line for connection to
communication apparatus and a plurality of element feed-lines for connection to a like
plurality of cylindrical helix antenna elements according to claim 1, said phased array
25 feed network being adapted to collectively connect said plurality of cylindrical helix
antenna elements to the communication apparatus; and

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said plurality of cylindrical helix antenna elements, said cylindrical helix antenna elements being disposed above said ground plane, each said cylindrical helix antenna element being individually connectable at a respective said first helix end located near the ground plane to a respective element feed-line of the phased array feed network to
5 thereby connect to the communications apparatus.

9. An antenna according to claim 8, wherein the plurality of cylindrical helix antenna elements are arranged in a domino pattern.

10 10. An antenna comprising:

a phased array feed network having an equipment feed-line for connection to communication apparatus and a plurality of element feed-lines for connection to a like plurality of cylindrical helix antenna elements, said phased array feed network being adapted to collectively connect said plurality of cylindrical helix antenna elements to the
15 communication apparatus; and

said plurality of cylindrical helix antenna elements arranged in a domino pattern, each said cylindrical helix antenna element comprising a ground plane and a cylindrical helix having a uniform pitch disposed above the ground plane, each said cylindrical helix antenna element being individually connectable at a respective first cylindrical helix end
20 located near the ground plane to a respective element feed-line of the phased array feed network to thereby connect said cylindrical helix antenna element to the communications apparatus, wherein each said cylindrical helix antenna element further comprises a lateral spiral substantially centred on the axis of the cylindrical helix the lateral spiral having a first end thereof connected to a second helix end being the opposite end of the cylindrical
25 helix to the first helix end, said spiral thereby terminating the antenna.

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11. An antenna according to claim 9 or claim 10, wherein:

the radial inter-element spacing between the centre antenna element and antenna elements at said corners of the domino pattern is between 0.5λ and 2.5λ at the frequency of operation of the antenna.

5

12. An antenna having two antennas according to claim 9 or claim 10, wherein:

a centre cylindrical helix antenna element of a first of said two antennas is co-located with a centre cylindrical helix antenna element of a second of said two antennas; and

10 the first of said two antennas is laterally rotated with respect to the second of said two antennas, said lateral rotation being about a common axis of the co-located centre cylindrical helix antenna elements to thereby change inter-element spacing between antenna elements of said two antennas.

15 13. An antenna comprising:

a ground plane:

a plurality of cylindrical helices disposed above the ground plane, each said cylindrical helix being connectable, via a respective feed line of an associated phased array feed network to a communications apparatus, at a respective first helix end located
20 near the ground plane; and

a like plurality of lateral spirals, each substantially centred on the axis of the corresponding one of the plurality of cylindrical helices, said each lateral spiral having a first end thereof connected to a second helix end of the corresponding one of the plurality of helices, said second helix end being the opposite end of the cylindrical helix to the first
25 helix end, said lateral spiral thereby terminating the corresponding helix.

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14. An antenna comprising:

a ground plane:

a plurality of cylindrical helices disposed above the ground plane, each said
5 cylindrical helix being connectable, via a respective feed line of an associated switched
element feed network to a communications apparatus, at a respective first helix end
located near the ground plane; and

a like plurality of lateral spirals, each substantially centred on the axis of the
corresponding one of the plurality of cylindrical helices, said each lateral spiral having a
10 first end thereof connected to a second helix end of the corresponding one of the plurality
of cylindrical helices, said lateral spiral thereby terminating the corresponding helix.

15. An antenna comprising:

a phased array feed network having an equipment feed-line for connection to
15 communication apparatus and a plurality of element feed-lines for connection to a like
plurality of cylindrical helix antenna elements, said phased array feed network being
adapted to collectively connect said plurality of cylindrical helix antenna elements to the
communication apparatus; and

said plurality of cylindrical helix antenna elements according to claim 1, said
20 helix antenna elements being disposed above said ground plane and arranged in a
rectangular grid pattern having a first spacing between rows of said rectangular grid
pattern and a second spacing between columns of said rectangular grid pattern, each said
cylindrical helix antenna element being individually connectable at a respective first helix
end located near the ground plane to a respective element feed-line of the phased array
25 feed network to thereby connect to the communications apparatus.

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16. A method of impedance matching a cylindrical helix antenna element wherein the cylindrical helix antenna element comprises a ground plane, a cylindrical helix having a uniform pitch disposed above the ground plane, the cylindrical helix being connectable to a communications apparatus at a first helix end located near the ground plane, and a
5 lateral spiral substantially centred on the axis of the cylindrical helix the lateral spiral having a first end thereof connected to a second helix end, said second helix end being the opposite end of the cylindrical helix to the first helix end, said lateral spiral thereby terminating the cylindrical helix antenna, said method comprising the steps of:

adjusting a distance, from the ground plane, of the first helix end located near the
10 ground plane to thereby adjust the impedance of a tapered transmission line formed between the ground plane and a first quarter turn of the cylindrical helix.